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PWS\_2430001\_CO\_20140627\_CTSTUDY

## Texas Commission on Environmental Quality

*Protecting Texas by Reducing and Preventing Pollution*

June 27, 2014

Mr. Mark Southard  
Water Source/Purification Superintendent  
City of Wichita Falls  
4801 Big Ed Neal Drive  
Wichita Falls, Texas 76310

Subject: Public Drinking Water System Contact Time Study  
City of Wichita Falls - PWS ID No. 2430001  
Cypress 2010 Water Treatment Plant, TCEQ Plant ID No. TP410071  
Wichita County, Texas

CN600129316

RN105598759

Dear Mr. Southard:

The Texas Commission on Environmental Quality (TCEQ) Technical Review and Oversight Team (TROT) has completed the review of the revised CT Study for the 2010 Cypress Water Treatment Plant (2010 WTP) which was submitted on April 25, 2014. The revision was submitted because the plant is being used as part of the treatment sequence for the City's temporary Direct Potable Reuse Project (DPR Project) and has been isolated from the 1961 and 1987 plants at the Cypress WTP site. The revision is submitted for the full scale operation of the treatment scheme. Based on the information provided, we are approving the proposed revisions. The information in this letter supersedes and does not supplement any previous CT study correspondence for the Cypress

Please note this letter does not waive any of the conditions required in the TCEQ's exception letter dated June 27, 2014 and applies when the temporary DPR Project is in operation. As you are aware, the City will need to submit another CT Study update at the conclusion of the temporary DPR Project.

During the temporary DPR Project, the raw water for the 2010 Cypress WTP will be a blend of surface water pumped from the Secondary Reservoir and RO permeate pumped from the RO Lagoon. The source of the water in the Secondary Reservoir is Lake Kickapoo and Lake Arrowhead and the source of the water in the RO Lagoon is the RO permeate produced by the 2008 Cypress Microfiltration/Reverse Osmosis Water Treatment Plant (2008 Cypress MF/RO WTP) which is treating the effluent from the River Road Waste Water Treatment Plant.

For the duration of the temporary DPR Project, the 2010 WTP will include a splitter box (which, under normal, non-emergency DPR operating conditions, distributes water between the 1961, 1987, and 2010 plants); a mechanical rapid mix; a Parshall Flume meter; a solids contact, slurry recirculation clarifier; a recarbonation basin; five dual-media gravity filters; the small 2010 Clearwell and filtered water transfer pump station; and the 10 million gallon (MG) 2010 Ground Storage Tank (GST) that has been isolated from the rest of the GSTs at the Cypress site; and the 2010 High Service Pump Station (HSPS) that discharges to the distribution system.

During the temporary DPR Project, the proposed disinfection protocol at the 2010 Cypress WTP involves the injection of chlorine dioxide ( $\text{ClO}_2$ ) at the Secondary Reservoir raw water transfer pumps, followed by the injection of chlorine ( $\text{Cl}_2$ ) and ammonia ( $\text{NH}_3$ ) at the outlet of the splitter box. There are also standby/secondary  $\text{Cl}_2$  and  $\text{NH}_3$  injection points at the 2010 Clearwell and the HSPS. Disinfectant residual monitoring can be performed at three designated sample sites on the Secondary Reservoir transmission line, and upstream of the rechloramination points at the 2010 Clearwell and HSPS.

A disinfection zone is a segment of the treatment process which begins at a disinfectant application point and ends at a subsequent disinfectant application or residual sampling point. Hence, each disinfectant application point regardless of the frequency of use represents the beginning of a separate disinfection zone. Similarly, a plant may have only one disinfectant point, but may also choose to monitor disinfection residuals at more than one point, thus creating multiple disinfection zones.

Based on the proposal you submitted, we concur that there are three disinfection zones at the 2010 Cypress WTP. The first disinfection zone, D1, consists of the three parallel trains that represent the three sampling location on the raw water line; Zone D1A represents the monitoring point located 400 feet downstream of the injection point, Zone D1B represents the monitoring point located 900 feet downstream of the injection point, and Zone D1C represents the monitoring point located 6,500 feet downstream of the injection point. The second disinfection zone, D2, contains the rapid mix, clarifier, recarbonation basin, granular media filters, and associated piping. The last disinfection zone, D3, incorporates the 2010 Clearwell and 2010 GST and the associated piping.

Contact Time (CT) calculations are used to evaluate the disinfection process. The time that the disinfectant is in contact with water in the disinfection segment must be determined on a daily basis to complete the CT calculations. This contact time, measured as  $T_{10}$ , is determined based on the peak hourly flow rate occurring during the 24-hour period and the detention time that is equaled or exceeded by 90 percent of the water passing through the basin. Since  $T_{10}$  values are required to calculate the CT for the treatment process, Table 1 was developed for the 2010 WTP while it is operating as part of the DPR treatment process. The  $T_{10}$  values are based on the information provided in the CT Study template you submitted on April 25, 2014.

**TABLE 1: T<sub>10</sub> TABLE FOR THE 2010 CYPRESS WATER TREATMENT PLANT (TP410071)  
DURING THE TEMPORARY DIRECT POTABLE REUSE PROJECT**

| DISINFECTION ZONE | TREATMENT UNIT                                               | VOLUME (GAL)              | FLOW RATE (MGD)      | BAFFLING FACTOR     | T <sub>10</sub> (MIN) |       |
|-------------------|--------------------------------------------------------------|---------------------------|----------------------|---------------------|-----------------------|-------|
|                   |                                                              |                           |                      |                     | Unit                  | Sum   |
| D1A               | Segment 1 of the raw water line from the Secondary Reservoir | 28,800 <sup>(1)</sup>     | 5.0 <sup>(11)</sup>  | 1.0 <sup>(14)</sup> | 8.3                   | 8.3   |
| D1B               | Segments 1 and 2 of the raw water line                       | 64,800 <sup>(2)</sup>     |                      | 1.0 <sup>(14)</sup> | 18.7                  | 18.7  |
| D1C               | All three segments of the raw water line                     | 467,900 <sup>(3)</sup>    |                      | 1.0 <sup>(14)</sup> | 134.7                 | 134.7 |
| D2                | Piping                                                       | 14,800 <sup>(4)</sup>     | 10.0 <sup>(12)</sup> | 1.0 <sup>(14)</sup> | 2.1                   | 67.1  |
|                   | Rapid Mix                                                    | 4,850 <sup>(5)</sup>      |                      | 0.1 <sup>(15)</sup> | 0.1                   |       |
|                   | Clarifier                                                    | 926,500 <sup>(6)</sup>    |                      | 0.3 <sup>(16)</sup> | 40.0                  |       |
|                   | Recarbonation Basin                                          | 183,000 <sup>(7)</sup>    |                      | 0.5 <sup>(17)</sup> | 13.2                  |       |
|                   | Granular Media Filters                                       | 29,100 <sup>(8)</sup>     | 2.5 <sup>(13)</sup>  | 0.7 <sup>(18)</sup> | 11.7                  |       |
| D3                | 2010 Clearwell                                               | 109,100 <sup>(9)</sup>    | 10.0 <sup>(12)</sup> | 0.5 <sup>(17)</sup> | 7.9                   | 223.3 |
|                   | 2010 Ground Storage Tank                                     | 4,987,000 <sup>(10)</sup> |                      | 0.3 <sup>(19)</sup> | 215.5                 |       |

**Notes:**

1. Based on a 42-inch diameter pipe with 400 feet between the injection point and the D1A sample tap.
2. Based on a 42-inch diameter pipe with 900 feet between the injection point and the D1B sample tap.
3. Based on a 42-inch diameter pipe with 6,500 feet between the injection point and the D1C sample tap.
4. Based on cumulative volume in 220 linear feet of 36-inch piping between the splitter box to the rapid mix and 85 linear feet of 30-inch piping from the rapid mix to the 2010 clarifier.
5. Based on a basin that is 27 feet long and 6 feet wide with a water depth of 4 feet.
6. Based on a 90-foot diameter clarifier with a side water depth of 18.9 feet and a center water depth of 20.6 feet.
7. Based on a basin that is 45.5 feet long and 32 feet wide and has a 16.8-foot side water depth.
8. Based on one dual-media gravity filter that is 24 feet long and 15 feet wide, contains 6 feet of gravel and media, and a 1-foot underdrain system. The minimum water depth over the media was reported to be 6.8 feet and a 50% porosity of the filter media is assumed.
9. Based on a clearwell that is 98.4 feet long and 26 feet wide. The maximum water depth and minimum operating levels in the clearwell are 11.3 feet and 5.7 feet, respectively.
10. Based on a tank that has a 206-foot diameter, a 40-foot maximum water depth, and a 20-foot minimum operating level.
11. Based on the design capacity of the DPR Project and the assumption that 50% of the source water for the 2010 Cypress WTP will be obtained from the raw water transfer pumps at the Secondary Reservoir.
12. Based on the design capacity of the DPR Project.
13. Based on the design capacity of the DPR Project. Assumes equal flow divided between identical units and that four filters will always be in operation.
14. Assumes that the flow conditions that exist in long pipeline segments will virtually eliminate the possibility of short-circuiting and create "perfect" baffling characteristics.
15. Assumes the rapid mix completely mixes the water within the unit and results in an "unbaffled" baffling characteristic within the basin.
16. Assumes that the mixing zone within the solids contact clarifier results in sufficient short-circuiting that the overall baffling characteristic of the clarifier will be "poor".
17. Assumes that "average" baffling conditions will occur in a tank that contains multiple baffle walls that create a contactor with an effective length:width ratio greater than 20:1 but less than 50:1.
18. Assumes that the hydraulic conditions that exist in a gravity filter will create "superior" baffling characteristics.
19. Assumes that a tank with two inlets, three internal baffle walls, and a single outlet will exhibit some short-circuiting and demonstrate "poor" baffling characteristics.

We have prepared a Disinfection Process Parameters table to help the operators complete their Surface Water Monthly Operating Report (SWMOR). In Table 2, we have characterized the  $T_{10}$  available in each of the disinfection zones based on the flow rate through the unit(s) that contributes most to the disinfection process within that zone. We have also provided the operators with the disinfection requirements that the 2010 Cypress WTP must meet on a continuous basis.

**TABLE 2: DISINFECTION PROCESS PARAMETERS FOR THE  
2010 CYPRESS WATER TREATMENT PLANT (TP410071)  
DURING THE TEMPORARY DIRECT POTABLE REUSE PROJECT**

| APPROVED CT STUDY PARAMETERS |                    |      |       |       |       | PERFORMANCE STANDARDS |         |
|------------------------------|--------------------|------|-------|-------|-------|-----------------------|---------|
| Parameters                   | Disinfection Zones |      |       |       |       | Log Inactivation      |         |
|                              | D1A                | D1B  | D1C   | D2    | D3    | Giardia               | Viruses |
| Flow Rate (MGD)              | 5.00               | 5.00 | 5.00  | 10.00 | 10.00 | 0.5                   | 2.0     |
| $T_{10}$ (minutes)           | 8.3                | 18.7 | 134.7 | 67.1  | 223.3 |                       |         |

As you are aware, zone D2 includes the 2010 clarifier, recarbonation basin, and filters. As we have discussed, this grouping of treatment processes results in some constraints on the manner in which the plant can be operated and monitored. Specifically:

- **The operators must monitor the pH in disinfection zone D2 at the outlet of the 2010 clarifier.** Historically, the plant has practiced full lime softening and, therefore, the clarifier has operated at a higher pH range in order to achieve greater hardness reductions and improved total organic carbon removal. During the temporary DPR project, the 2010 Cypress WTP expects to meet these two treatment objectives by blending the surface water (from Lake Kickapoo and Lake Arrowhead) with RO permeate produced by the 2008 Cypress MF/RO WTP plant. However, the City would like to retain the flexibility to practice partial lime softening when conditions warrant.

This desired level of flexibility is understandable. However, the US Environmental Protection Agency's CT Tables for chloramine only apply at pH levels between 6 and 9, i.e, from 5.5 through 9.49. Because zone D2 includes both the clarification and recarbonation processes and recarbonation lowers pH, the pH in zone D2 must be measured before recarbonation. Consequently, the operators must monitor the pH for disinfection zone D2 at the outlet of the clarifiers rather than at the typical site located at the end of the disinfection zone. The alternate location will ensure that the 2010 Cypress WTP plant does not overestimate disinfection levels when the clarifier pH reaches 9.5.

- **The operators must have at least four filters in operations whenever the plant is treating water.** This operational constraint is needed because zone D2 contains both the plant's gravity filters and the disinfection contact time within the zone depends on the flow rate of the water and the total volume of water contained in the treatment units. Consequently, the CT calculations will overestimate the level of viral inactivation achieved if fewer than four filters are on line whenever the plant is treating water.

Mr. Mark Southard  
Page 5 of 5  
June 27, 2014

Please be aware that the plant staff must continue using the approved amperometric method to measure the chlorine dioxide residuals at the disinfection zone D1A, D1B, D1C sampling points as well as at the entry point to the distribution system. However, chlorine dioxide samples collected in the distribution system, if necessary, may be analyzed using the colorimetric method and a colorimeter in the field.

It is also important to note that this approved CT study is only applicable for the duration of the temporary DPR Project and only if the plant adheres to the operational constraints identified above. **Therefore, you must submit another revised CT study when the plant returns to its traditional source water and operational practices.**

If you have any questions concerning our evaluation or if we may be of other assistance, please contact Mr. Joel Klumpp at (512) 239-4453, by e-mail at [joel.klumpp@tceq.texas.gov](mailto:joel.klumpp@tceq.texas.gov), or by correspondence at:

Technical Review and Oversight Team (MC-159)  
Texas Commission on Environmental Quality  
P.O. Box 13087  
Austin, TX 78711-3087

Sincerely,



Joel Klumpp, Team Leader  
Technical Review and Oversight Team  
Plan & Technical Review Section  
Water Supply Division  
Texas Commission on Environmental Quality



Cindy Haynie, CT Study Program Manager  
Technical Review and Oversight Team  
Plan & Technical Review Section  
Water Supply Division  
Texas Commission on Environmental Quality

JPK/jcs

Enclosure: CT Study Template

cc w/ enclosure: Mr. Daniel K. Nix,  
Operations Manager, Public Utilities  
City of Wichita Falls

Mr. Mark Southard  
Page 6 of 5  
June 27, 2014

*Blind Copies:*

bcc w/ enclosure: TCEQ Region 3, Abilene  
TCEQ Tracer Study File  
Mr. Donald Hunter, TCEQ DWQT, MC 155

# CT Study for the 2010 Cypress WTP

## CT STUDY TEMPLATE

FOR PUBLIC WATER SYSTEMS THAT ARE USING SURFACE WATER SOURCES  
OR GROUND WATER SOURCES UNDER THE INFLUENCE OF SURFACE WATER (cont.)

### Description Worksheet

#### PUBLIC WATER

SYSTEM NAME: City of Wichita Falls PWS ID No.: 2430001

#### PLANT NAME

OR NUMBER: 2010 Cypress Water Treatment Plant Month: April  
Day: 25  
Year: 2014

#### Enter a detailed narrative description of the plant treatment processes and disinfection protocol.

The City of Wichita Falls Cypress Water Treatment Plant (CWF CWTP) Temporary Reuse Project will combine the use of the Micro-filtration/Reverse Osmosis (MF/RO) treatment facilities with the conventional 2010 CWTP. This CT study takes into account the treated water pumped from the CWF River Road Waste Water Treatment Plant (RRWWTP) to the CWTP through a 30 inch raw water pipe at a flow of 7.5 million gallons per day (MGD), through the MF/RO treatment facility to a raw water lagoon where 5.0 MG will then be mixed with 5.0 MG raw surface water and treated through the conventional 2010 CWTP. The treatment process includes clarification prior to micro-filtration, reverse osmosis where the 5.0 MG permeate will be sent to a raw water lagoon, pumped back to the splitter basin and mixed with 5.0 MG of raw surface water prior to the 2010 CWTP.

The 2010 CWTP consists of a rapid mix basin, a 90-foot diameter (dia.) clarifier, a re-carbonation basin, five multi-media gravity filters, a 0.20-million gallon (MG) clearwell and pump station and a 10-MG ground storage tank. Total capacity through the 2010 CWTP is 10 MGD.

The treatment processes for the water from Lake Arrowhead and Lake Kicapoo through the CWF's Secondary Reservoir must achieve a 2.0-log removal or inactivation of Cryptosporidium, a 3.0-log removal or inactivation of Giardia, and a 4.0-log removal or inactivation of viruses before water is distributed to the customers. Based on the combination of treatment processes that will be used at 2010 CWTP, the disinfection process must be able to achieve a 0.5-log inactivation of Giardia and a 2.0-log inactivation of viruses before treated water enters the distribution system.

However, it should be noted that higher levels of inactivation may be required at the 2010 CWTP so that the reuse water from the RRWWTP, which will be passing through the CWTP treatment processes, will be adequately disinfected before treatment is complete and it enters the distribution system.

The proposed disinfection protocol involves the injection of chlorine dioxide (ClO<sub>2</sub>) downstream of the secondary reservoir, and chlorine (Cl<sub>2</sub>) and liquid ammonia gas (NH<sub>4</sub>) at the outlet of the splitter basin and upstream of the 0.20-MG clearwell and transfer pump station. Chlorine dioxide residual can be measured at three locations along the 42-inch raw water pipe at 400, 900 and 6500 linear feet downstream of the reservoir pump station, prior to entering the splitter basin. Since Cl<sub>2</sub> and NH<sub>4</sub> are added at the same location at the splitter basin, a measurable ClO<sub>2</sub> residual must be maintained at the 400 ft sample tap. Chloramine residual is monitored downstream of the five multi-media gravity filters and downstream of the Cypress high service pumps, prior to entering the distribution system.

Submitted by: Mark Southard, Water Source/Purification Superintendent

Contact: mark.southard@wichitafallstx.gov Reviewed by Jack C. Schulze, P.E.

Information: 940-691-1153, 940-691-4121 Fax

# CT Study for the 2010 Cypress WTP

## Detailed narrative description of the plant treatment processes and disinfection protocol (cont)

The disinfection process will utilize three disinfection zones which are summarized as follows:

D1A: The segment of the raw water pipeline from the chlorine dioxide injection point to the first monitoring point

D1B: The segment of the raw water pipeline from the chlorine dioxide injection point to the second chlorine dioxide monitoring point

D1C: The segment of the raw water pipeline from the chlorine dioxide injection point to the third chlorine dioxide monitoring point

D2: The 2010 clarifier, recarbonation basin, multi-media gravity filters, and associated piping

D3: The 2010 SWTP 0.20-MG clearwell and 10-MG ground storage tank

CT STUDY

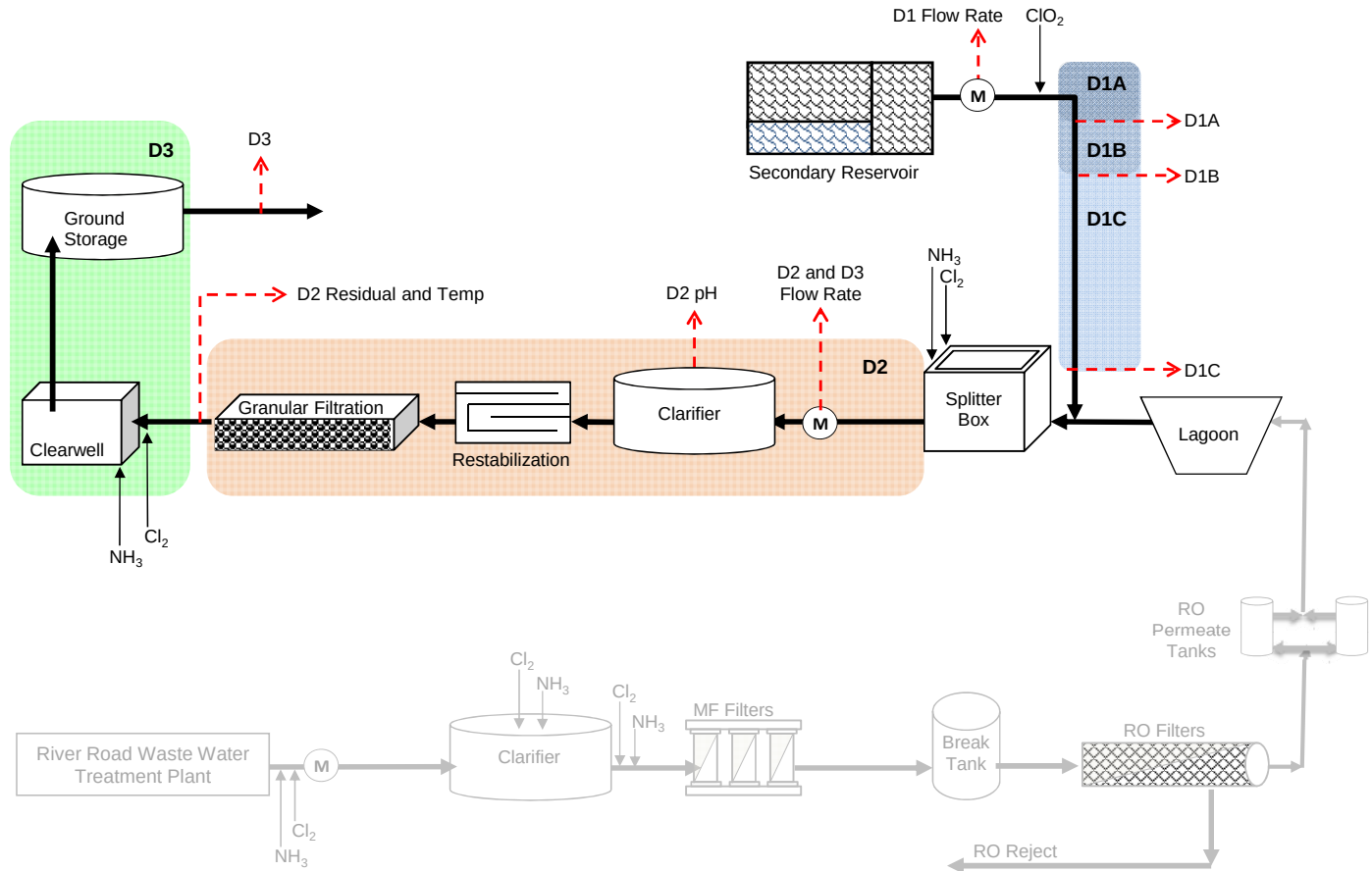
# CT Study for the 2010 Cypress WTP

## CT STUDY TEMPLATE

FOR PUBLIC WATER SYSTEMS THAT ARE USING SURFACE WATER SOURCES  
OR GROUND WATER SOURCES UNDER THE INFLUENCE OF SURFACE WATER (cont.)  
*Schematic Worksheet*

|                              |                       |                          |                                    |
|------------------------------|-----------------------|--------------------------|------------------------------------|
| PUBLIC WATER<br>SYSTEM NAME: | City of Wichita Falls | PLANT NAME<br>OR NUMBER: | 2010 Cypress Water Treatment Plant |
| PWS ID No.:                  | 2430001               | Date:                    | April 25, 2014                     |

Use this worksheet to create your plant schematic with the Microsoft Drawing Tools.  
If you are not familiar with the drawing tools, you may create your schematic using any other suitable medium.  
Please refer to Section 3.3 of the Guidance Manual for instructions and guidance.



**CT Study for the 2010 Cypress WTP  
T10 Details Worksheet**

**CT STUDY TEMPLATE**

FOR PUBLIC WATER SYSTEMS THAT ARE USING SURFACE WATER SOURCES  
OR GROUND WATER SOURCES UNDER THE INFLUENCE OF SURFACE WATER (cont.)  
*T10 Details Worksheet*

**PUBLIC WATER**  
**SYSTEM NAME:** City of Wichita Falls **PWS ID No.:** 2430001

**PLANT NAME**  
**OR NUMBER:** 2010 Cypress Water Treatment Plant **Date:** April 25, 2014

**Treatment Plant Capacity** 10.000 mgd  
6,944 gpm

Based on the combined flow rate from the MF/RO facilities and the secondary reservoir containing the raw water from Lake Arrowhead and Lake Kicakpoo through the Secondary Reservoir.

**Disinfection Zone:** D1A **Disinfectant:** Chlorine Dioxide

**Unit - 1** **Type:** Piping **Shape:** Pipe

**Further Description:** 42 Inch Raw Water Line From Secondary Reservoir to Cypress WTP

Characteristic

Comments

Number of Units

1

From Secondary Reservoir to first sample tap or raw water pipeline.

Diameter

42 in

As per CT Submittal Dated April 4, 201:

Length

400 ft

As per CT Submittal Dated April 4, 201:

Volume (each)

28,792 gal

Based on a 5 MGD Flow Rate of raw water from Lake Arrowhead

Flow Rate (each)

3,472 gpm

Detention Time

8.3 min

Baffling Factor

1.0

Typical Baffling Factor for Pipe

Baffling Characteristics: Perfect

Approved Baffling Factor:

T<sub>10</sub>

8.3 min

**D1A FLOW RATE** **5.000** mgd

**T10 SUM FOR D1A** **8.3** min

**CT Study for the 2010 Cypress WTP  
T10 Details Worksheet**

Disinfection Zone:     D1B     Disinfectant:     Chlorine Dioxide    

Unit - 1 Type:     Piping     Shape:     Pipe    

Further Description: 42 Inch Raw Water Line From Secondary Reservoir to Cypress WTP

| Characteristic   |            | Comments                                                    |
|------------------|------------|-------------------------------------------------------------|
| Number of Units  | 1          |                                                             |
| Diameter         | 42 in      | As per CT Submittal Dated April 4, 201:                     |
| Length           | 900 ft     | As per CT Submittal Dated April 4, 201:                     |
| Volume (each)    | 64,782 gal |                                                             |
| Flow Rate (each) | 3,472 gpm  | Based on a 5 MGD Flow Rate of raw water from Lake Arrowhead |
| Detention Time   | 18.7 min   |                                                             |
| Baffling Factor  | 1.0        | Typical Baffling Factor for Pipe                            |
|                  |            | Baffling Characteristics: <u>    Perfect    </u>            |
|                  |            | Approved Baffling Factor: <u>                    </u>       |
| T <sub>10</sub>  | 18.7 min   |                                                             |

|                        |                  |
|------------------------|------------------|
| <b>D1B FLOW RATE</b>   | <b>5.000 mgd</b> |
| <b>T10 SUM FOR D1B</b> | <b>18.7 min</b>  |

Disinfection Zone:     D1C     Disinfectant:     Chlorine Dioxide    

Unit - 1 Type:     Piping     Shape:     Pipe    

Further Description: 42 Inch Raw Water Line From Secondary Reservoir to Cypress WTP

| Characteristic   |             | Comments                                                    |
|------------------|-------------|-------------------------------------------------------------|
| Number of Units  | 1           |                                                             |
| Diameter         | 42 in       | As per CT Submittal Dated April 4, 201:                     |
| Length           | 6500 ft     | As per CT Submittal Dated April 4, 201:                     |
| Volume (each)    | 467,873 gal |                                                             |
| Flow Rate (each) | 3,472 gpm   | Based on a 5 MGD Flow Rate of raw water from Lake Arrowhead |
| Detention Time   | 134.7 min   |                                                             |
| Baffling Factor  | 1.0         | Typical Baffling Factor for Pipe                            |
|                  |             | Baffling Characteristics: <u>    Perfect    </u>            |
|                  |             | Approved Baffling Factor: <u>                    </u>       |
| T <sub>10</sub>  | 134.7 min   |                                                             |

|                        |                  |
|------------------------|------------------|
| <b>D1C FLOW RATE</b>   | <b>5.000 mgd</b> |
| <b>T10 SUM FOR D1C</b> | <b>134.7 min</b> |

**CT Study for the 2010 Cypress WTP  
T10 Details Worksheet**

**Disinfection Zone:** D2      **Disinfectant:** Chloramines

**Unit - 1**      Type: Piping      Shape: Pipe

Further Description: Raw Water Pipe from Splitter Box to Rapid Mix

| <u>Characteristic</u> |                | <u>Comments</u>                                                                                                               |
|-----------------------|----------------|-------------------------------------------------------------------------------------------------------------------------------|
| Number of Units       | 1              | Splitter box to rapid mix                                                                                                     |
| Diameter              | 36 in          | As per CT Submittal Dated April 4, 201:                                                                                       |
| Length                | 220 ft         | As per CT Submittal Dated April 4, 201:                                                                                       |
| Volume (each)         | 11,634 gal     |                                                                                                                               |
| Flow Rate (each)      | 6,944 gpm      | 10 MGD, the combined flow rate from the MF/RO facilities and the Secondary Reservoir containing raw water from Lake Arrowhead |
| Detention Time        | 1.7 min        |                                                                                                                               |
| Baffling Factor       | 1.0            | Typical Baffling Factor for Pipe                                                                                              |
|                       |                | Baffling Characteristics: <u>Perfect</u>                                                                                      |
|                       |                | Approved Baffling Factor: _____                                                                                               |
| <b>T<sub>10</sub></b> | <b>1.7 min</b> |                                                                                                                               |

**Unit - 2**      Type: Rapid Mix      Shape: Rectangular

Further Description: Rapid Mix Basin

| <u>Characteristic</u> |                | <u>Comments</u>                                                             |
|-----------------------|----------------|-----------------------------------------------------------------------------|
| Number of Units       | 1              |                                                                             |
| Length                | 27 ft          | As per CT Submittal Dated April 4, 201:                                     |
| Width                 | 6 ft           | As per CT Submittal Dated April 4, 201:                                     |
| Side Water Depth      | 4 ft           | As per CT Submittal Dated April 4, 201:                                     |
| Volume (each)         | 4,848 gal      |                                                                             |
| Flow Rate (each)      | 6,944 gpm      | Based on a total 10 MGD flow through the conventional 2010 CWTP facilities. |
| Detention Time        | 0.7 min        |                                                                             |
| Baffling Factor       | 0.1            | Typical baffling factor for an "Unbaffled" basin                            |
|                       |                | Baffling Characteristics: <u>Unbaffled</u>                                  |
|                       |                | Approved Baffling Factor: _____                                             |
| <b>T<sub>10</sub></b> | <b>0.1 min</b> |                                                                             |

**Unit - 3**      Type: Piping      Shape: Pipe

Further Description: 30 Inch Pipe from Rapid Mix to Clarifier

| <u>Characteristic</u> |                | <u>Comments</u>                          |
|-----------------------|----------------|------------------------------------------|
| Number of Units       | 1              | Rapid Mix to Clarifier                   |
| Diameter              | 30 in          | As per CT Submittal Dated April 4, 201:  |
| Length                | 85 ft          | As per CT Submittal Dated April 4, 201:  |
| Volume (each)         | 3,122 gal      |                                          |
| Flow Rate (each)      | 6,944 gpm      | 10 MGD Flow                              |
| Detention Time        | 0.4 min        |                                          |
| Baffling Factor       | 1.0            | Typical baffling factor for pipe         |
|                       |                | Baffling Characteristics: <u>Perfect</u> |
|                       |                | Approved Baffling Factor: _____          |
| <b>T<sub>10</sub></b> | <b>0.4 min</b> |                                          |

**CT Study for the 2010 Cypress WTP  
T10 Details Worksheet**

**Unit - 4**                      Type: Clarifier                      Shape: Circular

Further Description: 2010 Plant Clarifier

| <u>Characteristic</u> |                 | <u>Comments</u>                                                                                                           |
|-----------------------|-----------------|---------------------------------------------------------------------------------------------------------------------------|
| Number of Units       | 1               |                                                                                                                           |
| Diameter              | 90 ft           | As per CT Submittal Dated April 4, 201:                                                                                   |
| Side Water Depth      | 18.9 ft         | As per CT Submittal Dated April 4, 201:                                                                                   |
| Center Water Depth    | 20.6 ft         | As per CT Submittal Dated April 4, 201:                                                                                   |
| Volume (each)         | 926,521 gal     |                                                                                                                           |
| Flow Rate (each)      | 6,944 gpm       | Based on the rated capacity of the temporary DPR WTP. At this flow rate, the SOR = 1.09 gpm/ft2 and the HDT = 133.42 min. |
| Detention Time        | 133.4 min       |                                                                                                                           |
| Baffling Factor       | 0.3             | Typical baffling factor for clarifier:<br>Baffling Characteristics: <u>Poor</u><br>Approved Baffling Factor: _____        |
| <b>T<sub>10</sub></b> | <b>40.0 min</b> |                                                                                                                           |

**Unit - 5**                      Type: Other                      Shape: Rectangular

Further Description: Recarbonation Basin

| <u>Characteristic</u> |                 | <u>Comments</u>                                                                                                                                                      |
|-----------------------|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Number of Units       | 1               |                                                                                                                                                                      |
| Length                | 45.5 ft         | As per CT Submittal Dated April 4, 201:                                                                                                                              |
| Width                 | 32 ft           | As per CT Submittal Dated April 4, 201:                                                                                                                              |
| Side Water Depth      | 16.8 ft         | As per CT Submittal Dated April 4, 201:                                                                                                                              |
| Volume (each)         | 183,003 gal     |                                                                                                                                                                      |
| Flow Rate (each)      | 6,944 gpm       | 10 MGD Flow                                                                                                                                                          |
| Detention Time        | 26.4 min        |                                                                                                                                                                      |
| Baffling Factor       | 0.5             | Typical baffling factor for basins with 4 internal baffles and length to width (40:1)<br>Baffling Characteristics: <u>Average</u><br>Approved Baffling Factor: _____ |
| <b>T<sub>10</sub></b> | <b>13.2 min</b> |                                                                                                                                                                      |

**CT Study for the 2010 Cypress WTP  
T10 Details Worksheet**

**Unit - 6**                      Type: Filter                      Shape: Rectangular

Further Description: 2010 Plant Gravity Filters

| <u>Characteristic</u>                               |            | <u>Comments</u>                                                                                                                                       |
|-----------------------------------------------------|------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|
| Number of Units                                     | 4          | To represent the City's operation with four filters always in service and the fifth filter on standby for when one of the filters goes into backwash. |
| Length                                              | 24 ft      | As per CT Submittal Dated April 4, 201:                                                                                                               |
| Width                                               | 15 ft      | As per CT Submittal Dated April 4, 201:                                                                                                               |
| Media Depth                                         | 6 ft       | As per CT Submittal Dated April 4, 201:                                                                                                               |
| Underdrain Depth                                    | 1 ft       | As per CT Submittal Dated April 4, 201:                                                                                                               |
| Minimum Water Depth Over Media                      | 6.8 ft     | As per CT Submittal Dated April 4, 201:                                                                                                               |
| Average Porosity                                    | 50 %       |                                                                                                                                                       |
| Volume (each)                                       | 29,088 gal |                                                                                                                                                       |
| Flow Rate (each)                                    | 1,736 gpm  | 10 MGD flow divided equally between four filters. Each filter is rated at 2.5 MGD. Four filters must always be operated together at equal flow rates. |
| Detention Time                                      | 16.8 min   |                                                                                                                                                       |
| Baffling Factor                                     | 0.7        | Typical baffling factor for filters<br>Baffling Characteristics: <u>Superior</u><br>Approved Baffling Factor: _____                                   |
| T <sub>10</sub>                                     | 11.7 min   |                                                                                                                                                       |
| <b>D2 FLOW RATE                      10.000 mgd</b> |            |                                                                                                                                                       |
| <b>T10 SUM FOR D2                      67.1 min</b> |            |                                                                                                                                                       |

**Disinfection Zone:**                      D3                      **Disinfectant:**                      Chloramines

**Unit - 1**                      Type: Clearwell                      Shape: Rectangular

Further Description: 2010 Clearwell/Transfer Pump Station

| <u>Characteristic</u>     |             | <u>Comments</u>                                                                                                                                                         |
|---------------------------|-------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Number of Units           | 1           |                                                                                                                                                                         |
| Length                    | 98.4 ft     | As per CT Submittal Dated April 4, 201:                                                                                                                                 |
| Width                     | 26 ft       | As per CT Submittal Dated April 4, 201:                                                                                                                                 |
| Side Water Depth          | 11.3 ft     | As per CT Submittal Dated April 4, 201:                                                                                                                                 |
| Maximum Volume (each)     | 216,290 gal |                                                                                                                                                                         |
| Minimum Operating Level   | 5.7 ft      | 50 % of total volume                                                                                                                                                    |
| Worst Case Volume (each)  | 109,102 gal |                                                                                                                                                                         |
| Percent of Maximum Volume | 50 %        |                                                                                                                                                                         |
| Worst Case Volume (each)  | 109,102 gal |                                                                                                                                                                         |
| Flow Rate (each)          | 6,944 gpm   | 10 MGD flow                                                                                                                                                             |
| Detention Time            | 15.7 min    |                                                                                                                                                                         |
| Baffling Factor           | 0.5         | Typical baffling factor for basins with two internal baffles with length to width (30:1)<br>Baffling Characteristics: <u>Average</u><br>Approved Baffling Factor: _____ |
| T <sub>10</sub>           | 7.9 min     |                                                                                                                                                                         |

**CT Study for the 2010 Cypress WTP  
T10 Details Worksheet**

Unit - 2                      Type: Clearwell                      Shape: Circular

Further Description: 10 MG Ground Storage Tank

| <u>Characteristic</u>     |               | <u>Comments</u>                                                                                                        |
|---------------------------|---------------|------------------------------------------------------------------------------------------------------------------------|
| Number of Units           | 1             |                                                                                                                        |
| Diameter                  | 206 ft        | As per CT Submittal Dated April 4, 201:                                                                                |
| Side Water Depth          | 40 ft         | As per CT Submittal Dated April 4, 201:                                                                                |
| Center Water Depth        | 40 ft         | As per CT Submittal Dated April 4, 201:                                                                                |
| Maximum Volume (each)     | 9,974,083 gal |                                                                                                                        |
| Minimum Operating Level   | 20 ft         | Assumes "Worst Case" operating leve                                                                                    |
| Worst Case Volume (each)  | 4,987,042 gal |                                                                                                                        |
| Percent of Maximum Volume | 50 %          |                                                                                                                        |
| Worst Case Volume (each)  | 4,987,042 gal |                                                                                                                        |
|                           |               | 100 % of 10 MGD max at Cypress. All water produced during the DPR Full Scale Operation will pass through the 10 MG GST |
| Flow Rate (each)          | 6,944 gpm     |                                                                                                                        |
| Detention Time            | 718.1 min     |                                                                                                                        |
| Baffling Factor           | 0.3           | Typical baffling factor for basins having 2 inlets, 1 outlet and 3 interior baffles.                                   |
|                           |               | Baffling Characteristics: <u>Poor</u>                                                                                  |
|                           |               | Approved Baffling Factor: _____                                                                                        |
| T <sub>10</sub>           | 215.4 min     |                                                                                                                        |

|                     |                   |
|---------------------|-------------------|
| <b>D3 FLOW RATE</b> | <b>10.000 mgd</b> |
|---------------------|-------------------|

|                       |                  |
|-----------------------|------------------|
| <b>T10 SUM FOR D3</b> | <b>223.3 min</b> |
|-----------------------|------------------|

|                    |           |               |       |
|--------------------|-----------|---------------|-------|
| Disinfection Zone: | <u>D4</u> | Disinfectant: | _____ |
| Disinfection Zone: | <u>D5</u> | Disinfectant: | _____ |
| Disinfection Zone: | <u>D6</u> | Disinfectant: | _____ |
| Disinfection Zone: | <u>D7</u> | Disinfectant: | _____ |
| Disinfection Zone: | <u>D8</u> | Disinfectant: | _____ |

# CT Study for the 2010 Cypress WTP

## CT STUDY TEMPLATE

FOR PUBLIC WATER SYSTEMS THAT ARE USING SURFACE WATER SOURCES  
OR GROUND WATER SOURCES UNDER THE INFLUENCE OF SURFACE WATER (cont.)

### Summary Worksheet

PUBLIC WATER

SYSTEM NAME: City of Wichita Falls PWS ID No.: 2430001

PLANT NAME

OR NUMBER: 2010 Cypress Water Treatment Plant Date: April 25, 2014

| Disinfection Zone | Treatment Unit                                     | Volume*<br>(each)<br>(gal) | Flow Rate*<br>(each)<br>(MGD) | Baffling Factor* | T <sub>10</sub> *<br>(min) |        |
|-------------------|----------------------------------------------------|----------------------------|-------------------------------|------------------|----------------------------|--------|
|                   |                                                    |                            |                               |                  | Unit                       | Zone   |
| D1A               | Raw Water Line From Secondary Reservoir to Cypress | 28,792                     | 5.000                         | 1                | 8.292                      | 8.29   |
| D1B               | Raw Water Line From Secondary Reservoir to Cypress | 64,782                     | 5.000                         | 1                | 18.657                     | 18.66  |
| D1C               | Raw Water Line From Secondary Reservoir to Cypress | 467,873                    | 5.000                         | 1                | 134.747                    | 134.75 |
| D2                | Raw Water Pipe from Splitter Box to Rapid Mix (1)  | 11,634                     | 10.000                        | 1                | 1.675                      | 67.12  |
|                   | Rapid Mix Basin (1)                                | 4,848                      | 10.000                        | 0.1              | 0.070                      |        |
|                   | 30 Inch Pipe from Rapid Mix to Clarifier (1)       | 3,122                      | 10.000                        | 1                | 0.450                      |        |
|                   | 2010 Plant Clarifier (1)                           | 926,521                    | 10.000                        | 0.3              | 40.026                     |        |
|                   | Recarbonation Basin (1)                            | 183,003                    | 10.000                        | 0.5              | 13.176                     |        |
| D3                | 2010 Plant Gravity Filters (4)                     | 29,088                     | 2.500                         | 0.7              | 11.728                     | 223.30 |
|                   | 2010 Clearwell/Transfer Pump Station (1)           | 109,102                    | 10.000                        | 0.5              | 7.855                      |        |
|                   | 10 MG Ground Storage Tank (1)                      | 4,987,042                  | 10.000                        | 0.3              | 215.440                    |        |

\* These values are calculated on the T10 Details Sheet

TCEQ - (05-01-13)

CT STUDY

# CT Study for the 2010 Cypress WTP

## CT STUDY TEMPLATE

FOR PUBLIC WATER SYSTEMS THAT ARE USING SURFACE WATER SOURCES  
OR GROUND WATER SOURCES UNDER THE INFLUENCE OF SURFACE WATER (cont.)  
CT Calculator Worksheet

PUBLIC WATER SYSTEM NAME: City of Wichita Falls PLANT NAME OR NUMBER: 2010 Cypress Water Treatment Plant  
PWS ID No.: 2430001 Date: April 25, 2014

| DISINFECTION PROCESS PARAMETERS |                    |       |       |        |        |                       |  |         |  |
|---------------------------------|--------------------|-------|-------|--------|--------|-----------------------|--|---------|--|
| APPROVED CT STUDY PARAMETERS    |                    |       |       |        |        | PERFORMANCE STANDARDS |  |         |  |
| Parameters                      | Disinfection Zones |       |       |        |        | Log Inactivations     |  |         |  |
|                                 | D1A                | D1B   | D1C   | D2     | D3     | Giardia lamblia Cysts |  | Viruses |  |
| Flow Rate (MGD)                 | 5.000              | 5.000 | 5.000 | 10.000 | 10.000 | 0.5                   |  | 2.0     |  |
| T <sub>10</sub> (minutes)       | 8.3                | 18.7  | 134.7 | 67.1   | 223.3  |                       |  |         |  |

| DISINFECTION PROCESS DATA     |          |            |           |     |                    |                            |                          |             |           |             |           |              |
|-------------------------------|----------|------------|-----------|-----|--------------------|----------------------------|--------------------------|-------------|-----------|-------------|-----------|--------------|
| INDIVIDUAL DISINFECTION ZONES |          |            |           |     |                    |                            |                          |             |           | PLANT TOTAL |           |              |
| Disinfectant                  | C (mg/L) | Flow (MGD) | Temp (°C) | pH  | CT <sub>CALC</sub> | Giardia CT <sub>REQD</sub> | Virus CT <sub>REQD</sub> | Giardia Log | Virus Log | Giardia Log | Virus Log | Inact. Ratio |
| CLO2 D1A                      | 0.05     | 5.000      | 5.0       | 8.2 | 0.4                | 4.5                        | 5.7                      | 0.05        | 0.14      |             |           |              |
| NA D1B                        |          |            |           |     | NA                 | NA                         | NA                       | NA          | NA        |             |           |              |
| NA D1C                        |          |            |           |     | NA                 | NA                         | NA                       | NA          | NA        | 1.56        | 2.67      | 1.34         |
| CLA D2                        | 3.50     | 10.000     | 5.0       | 9.0 | 234.9              | 357.5                      | 857.0                    | 0.33        | 0.55      | (V)         |           |              |
| CLA D3                        | 3.80     | 10.000     | 5.0       | 8.9 | 848.5              | 357.5                      | 857.0                    | 1.19        | 1.98      |             |           |              |

SUBMITTED BY: \_\_\_\_\_ Certificate No. and Grade: \_\_\_\_\_ Date: \_\_\_\_\_

TCEQ - (05-01-13)

CT STUDY